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The last third of the book is devoted to a brief analysis of human psychic activities and an argument that from the automatic movements of protists, something like faint rudimentary unconscious concepts may be assumed, and from their reflex movements unconscious sensations may be inferred, or at least are probable. The parts of divided protists make nearly the same movements in response to all the above kinds of stimulus as the entire animal, only the smaller the part the greater strength of stimulus is needed. Hence the nucleus is not the psychic centre, and "every elementary part of protoplasm has its own independent psyche." Ciliates are physically highest, rhizopods lowest among protists. The movements described, our author believes, are "identical with the molecular processes in protoplasm." There is no distinction between psychic and physiological movement. It is impossible to separate the idea of psyche from the idea of life. While it is proved that this molecular psychology is the most primitive, it remains to demonstrate what is already undoubted, that these processes are the bridge to connect the chemical processes of inorganic nature with the soul-life of the highest animals. As the vital processes in man are related to those of a cell, so are the latter to those of elementary parts of protoplasm, and so again are these last to the processes in any molecule whatever. This is the lofty monism which Demokritus, Bruno, Spinoza and Hæckel have attained, for which all differences between organic and inorganic, between psychic and material processes have vanished, and is to all dual or manifold ideas of the universe as of old monotheism was to all polytheisms.

*Der Heliotropismus der Thiere, und seine Uebereinstimmung mit dem Heliotropismus der Pflanzen*, von DR. J. LOEB, Assistent am physiolog. Inst. zu Strassburg. Würzburg, 1890. pp. 118. Preis 4 mark.

In his *Vorlesungen über Pflanzen-Physiologie* (2nd ed., Leipsic, 1887.) G. v. Sachs has summed up his remarkable experiments on heliotropism and kindred topics of plant life. Loeb (taking Sachs as his model) attempts to demonstrate all the same laws on lower animal forms, mostly insects. He began with a spinning species of caterpillar (*Porthesia Chrysorrhæa*), of which he put 100 in a reagent glass, and found however often the direction of the glass was reversed they always crept towards the light. If the end towards the light was covered by an opaque sheath they crept light-wards as far as the first edge of the sheath, and there paused. They will leave a lighter part of a tube and pass a long darker passage which opens towards light. They pass out of a ray of direct sunlight into shadow, or vice versa, to get nearer a source of light. For these, as for nearly all insects tested, red and yellow light are much less effective than blue and even violet, and ultra violet has little effect, and all these experiments work only at certain temperatures. Each insect showed the all-constraining tendency to bring the median plane of its body in the direction of the ray at a certain intensity varying with the species, and every insect showed the tendency if proper conditions were observed, so that there was no laborious counting of "parliamentary majorities," as with Lubbock's and Graber's ants. The effect of this stimulus was constant and the insects remained for days as near the light as they could get, and constantly "pointed" at it. Heliotropism is best studied in nearly horizontal directions to eliminate geotropic influences, the latter being however far weaker.

Why moths that only fly by night love the light is made no less a paradox by Romanes' anthropomorphic remark that a candle is a strange object they would examine. By artificial day and night Loeb could change their daily time of flight or rest but a few hours. All night flies so far as studied, are *positively* heliotropic, and never shun light itself. What seems the passion of so many creeping insects for corners,

cracks, and edges, and their dislike of open surfaces, is another confusing element to be eliminated, though weaker than heliotropism, and is named contact-irritability, or stereotropism. All these experiments are in general very simple and require almost no apparatus beyond glass cups, tubes, a window that can be partly darkened, and a prism.

Leaf-lice at rest usually turn the oral pole toward the stem, the aboral to the apex of a leaf, or lie in this sense along its veins if at rest. As soon as their wings grow, which may be caused artificially by gradually drying up the leaf, their orientation becomes heliotropic and independent of the leaf and very serviceable for these experiments. At the time of sexual maturity, or at the time of the "wedding flight," many insects become strongly heliotropic, when they are not so before or after. The tendency is to get the axis of the body in the direction of the ray of light, rather than to seek the strongest light. In one case with a rotatory polarization apparatus turning 3-4 times per second with a radius of 30 cm., a fly went round with the ray several times, thrice repeated. This observation of Mach, Loeb thinks, illustrates the constraining power of heliotropism. It might readily be carried further by a centrifugal machine. The protoplasm in the background of the human eye is positively heliotropic; pigment and cones press forward, if illuminated. The heliotropic conception of retinal space-sensations pre-supposes the *continuity* of protoplasm as the irritable substance, and rejects the theory of distinct visual elements—rods and cones. Heliotropic changes determine space-sensations, and this new view simplifies many problems. Heliotropism cannot rest on any specific properties of a central nervous system, for it is common where there are no nerves.

This pamphlet is very interesting, abounds in facts and suggestions and must be read to be fully appreciated. The work was undertaken to show—so we are told at the outset—that in all these phenomena there is no evidence whatever of sensation, instinct, preference, or anything whatever of a psychic nature. All heliotropic, geotropic, stereotropic, or thermotropic motions whatever are in their nature absolutely identical with analogous movements of plants, and he who wishes to see any rudiment or analogue of a bank of intelligent Raphael faces gazing on a central glory, as mediæval artists often dreamed of, in a mass of maggots or larvæ or caterpillars, every one flush with the edge of glass or beaker-rim nearest the light, and staying there for days, should here learn the far higher lesson of law and mechanism, such phenomena properly inculcate. The view of Loeb is in fact as speculative on one side as the anthropomorphism of Verworn (above) is on the other. The violent polemic tone of Loeb and his dogmatism on this old and purely theoretic, and as yet unanswerable question, the entire absence of all morphological or anatomical considerations, especially with the author's mechanical predilections and the *very* meagre evidence suggested to even countenance his revolutionary view of retinal space-perception, are each in different ways to be regretted. His work, however, opens up still wider a new and attractive field, wherein we hope to see psychology gradually strike many strong and deep roots into the rich soil of general biology.

*Der Zeitsinn.* MÜNSTERBERG. Beiträge zur experimentellen Psychologie. H. 2. 1889.

The second number of Münsterberg's series of psychological studies opens with an article in the much-confused field of the "time-sense." After resuming the results of previous experimenters, from Mach to Glass, and presenting at length (three-fifths of the whole paper), the theory to which he has been led by self-observation in the course of experimentation, he finally gives in a brief section the results of an experimental test of his theory. This theory is nothing less than a